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⑯ A vaccine for immunization against coccidiosis.

⑯ A vaccine can be used for immunizing chickens and other domestic animals of the avian species from coccidiosis. Oocysts of one or more coccidia are diluted in a 1.5% solution of carrageenan. The oocysts are uniformly suspended and maintain a uniform level of infection throughout the solution. The chickens or other animals to be vaccinated can be exposed to the vaccine by placing the animals in the same room as the vaccine and allowing the animals to drink the vaccine as they desire.

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necatrix and is the main cause of death among chickens suffering from coccidiosis, but also, because Eimeria tenella appears almost exclusively in the ceca of chickens instead of infecting all over the intestines like other species. As the infection is confined to one particular area of the chicken, the damage or lesion can be accurately scored.

5 As can be seen from Table 1, sporulated oocysts of Eimeria tenella suspended in a 1.5% solution of carrageenan (i.e. 1.5 grams of carrageenan per 100 millilitres of water) could be stored up to 6 months

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Table 1 - Uniform suspension of *Emmeria tenella* oocysts in 1.5% carrageenan solution.

Time Lapse	Experiment #1	Experiment #2	Experiment #3	Experiment #4	Experiment #5	Experiment #6
0 hour	97	110	101	107	101 (10)	106
1 hour	--	--	96	115	--	--
2 hours	91	91	98	88	--	--
3 hours	119	105	97	89	--	--
4 hours	--	--	94	97	--	--
20 hours	91	94	--	--	--	--
24 hours	--	--	113	105	--	--
20 days	--	--	--	--	98 (6)	--
6 months	--	--	--	--	--	94
means	1.5×10^4	1.3×10^4	1.4×10^4	1.4×10^4	2.1×10^4	3.5×10^5

Each number represents 4 replicates except Experiment #5. Numbers in parenthesis in Experiment #5 represent numbers of samples counted in 2 replicates each.

55 while remaining within plus or minus 15% of the mean number of oocysts. It is therefore not necessary to use the vaccine as soon as the oocysts are added to the non-sticky edible gum solution. However, as will be seen later, it is preferred that the solution be in liquid form as opposed to gel form. If the solution is in gel form at any time after the oocysts are added, it cannot be reconverted to liquid form as the increase in

temperature necessary to reconvert the solution to liquid form will kill at least some of the oocysts thereby significantly reducing the level of infectivity of said oocysts in said solution.

As indicated in Table 2, it was found that the amount of a 1.5% solution of carrageenan, containing 1.5 grams of carrageenan per 100 millilitres of water, had no effect on the infectivity of Eimeria tenella in chickens. In other words, the level of infectivity of Eimeria tenella remained the same regardless of the volume of non-sticky edible gum solution used. Therefore, the carrageenan solution does not trap or kill the sporozoites of the coccidium and does not reduce the level of infectivity of the oocysts in said solution.

Preferably, the controlled time period ranges from thirty minutes to four hours and, still more preferably, from one to three hours. It has been found that the best results are obtained when the controlled time period or exposure time ranges from one to three hours with consecutive exposure times being at least eighteen hours apart from one another. It is often convenient to have consecutive exposure times twenty-four hours apart from one another.

It has also been found that better resistance to coccidiosis is achieved when there is more than one exposure time. Preferably, the number of exposure times ranges from two to four.

The use of the vaccine in accordance with the invention is illustrated in the following examples but the invention is not limited thereto. A suitable level of infectivity for vaccination purposes of Eimeria tenella is 300 oocysts per millilitre of solution containing 1.5 grams of non-sticky edible gum per 100 millilitres of water. A suitable level of infectivity for Eimeria necatrix for vaccination purposes is 200 oocysts per millilitre of a solution containing 1.5 grams of non-sticky edible gum per 100 millilitres of water.

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Table 2 - Effect of the amount of carrageenan on the uniformity in infectivity of Eimeria tenella in chickens.

	Number of Oocysts	Millilitres of 1.5% Carrageenan	Mean Lesion Score ± S. D.
30	1 X 10 ⁴	0.25	5.5 ± 1.5
35	1 X 10 ⁴	0.5	4.6 ± 1.3
	1 X 10 ⁴	1.0	6.2 ± 1.4

Five birds per group.

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EXAMPLE #1

45 IMMUNIZATION OF CHICKENS AGAINST EIMERIA TENELLA WITH OOCYSTS SUSPENDED IN A 1.5% CARRAGEENAN SOLUTION (i.e. containing 1.5 grams of carrageenan per 100 millilitres of water).

Fifteen broilers, each one day old, were divided into three groups of five birds each. The first group served as a control group while the chickens of the second group were allowed to expose to Eimeria tenella 50 oocysts suspended at 300 oocysts per millilitre of 1.5% carrageenan solution for about one to two hours daily for two days. The third group was similarly treated except that it was exposed for four days rather than two days. At nine days of age, all birds were challenged with 20,000 oocysts of Eimeria tenella.

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Two of the fifteen challenged control birds died but none of the immunized birds died (see Table 4 below). The average lesion scores of the challenged birds were 3.0 and 3.5 for the immunized and control groups respectively.

Table 4 - Immunization of broiler chickens against *Eimeria necatrix*. Oocysts were suspended at 200 oocysts per millilitre of 1.5% of carrageenan solution (i.e. 1.5 grams of carrageenan per 100 millilitres of water).

15	Treatment	Mortality	Average Per Cent	Average Lesion
			Weight Change	Scores
16	Control, Non-immunized, Challenged	0/10	100% (104 gm)	0
20	Immunized, Challenged	0/10	95.2	0
25	Immunized, Challenged	0/10	59.6	3.0
	Control, Challenged	2/15	55.8	3.5

30 Birds were challenged with 20,000 oocysts of *Eimeria necatrix* 9 days after immunization.

It has been found that, at concentrations of carrageenan below 1.5%, the uniformity of the suspension of the oocysts decreased. While concentrations of carrageenan greater than 1.5% could be used, it would simply be more expensive without increasing the uniformity of suspension of the vaccine. In other words, additional carrageenan would be superfluous.

35 Large scale tests were carried out on broiler chickens using low levels of oocysts of *Eimeria acervulina*, *Eimeria maxima*, *Eimeria necatrix* and *Eimeria tenella* suspended in a 1.5% solution of carrageenan. The results of these tests is set out in Table 5. In all of the tests, the level of *Eimeria acervulina*, *Eimeria maxima*, *Eimeria necatrix* and *Eimeria tenella* in solution were approximately 1,000, 100, 170 and 170 oocysts per bird respectively at 4 days of age. The carrageenan solution containing the oocysts was poured into water troughs that had been previously dried by cutting off the water supply approximately 1/2 to 1 hour before the suspensions were poured. The birds were exposed again at 7 days of age to *Eimeria necatrix* and *Eimeria tenella*, each being at a level of approximately 130 oocysts per bird. The 1.5% carrageenan solution was first made by mixing approximately 57 grams of carrageenan in 3.8 litres of distilled water. The oocysts were added to make approximately 2,000 doses per 3.8 litres. Through tests 1 to 6, one half of the chickens were treated with the vaccine in accordance with the present invention. The remaining half of the birds were medicated with Monensin (a tread mark) in accordance with the manufacturer's instructions. In test #6, vaccination in accordance with the present invention was carried out in an identical manner to tests #1 to #5 except that the vaccine was chilled in a refrigerator overnight prior to use. The temperature of the refrigerator was approximately 4°C.

50 The results show that there were no significant differences in mortality, average weight gain or in feed conversion between the vaccinated and Monensin medicated birds through tests #1 to #5. However, in test #6, there was a relatively significant difference in the average weight gain. While the vaccine will still work in gel form, this result suggests that the vaccine in the gel form is not as satisfactory as vaccine in the solution form.

46 48 50 52 54 56 58 60 62 64 66 68 70 72 74 76 78 80 82 84 86 88 90 92 94 96 98 100

Table 5 - Large Scale Tests of Broiler Chickens

Test No.	Treatment	No. of Chickens Placed	(51 days)		
			Mortality (%)	Average Wt. (lbs)	Feed Conversion
1	Vaccination ^a Monensin (9ppm)	15,000 15,000	301 (2) 425 (2.8)	4.42 4.48	2.08 2.09
2	Vaccination ^a Monensin (9ppm)	12,000 12,000	97 (0.8) 87 (0.7)	4.21 4.31	2.12 2.10
3	Vaccination ^a Monensin (9ppm)	15,000 15,000	90 (0.6) 61 (0.4)	4.37 4.42	2.11 2.09
4	Vaccination ^a Monensin (9ppm)	15,000 15,000	588 (3.9) 468 (3.1)	4.18 4.22	2.11 2.11
5	Vaccination ^a Monensin (9ppm)	15,000 15,000	84 (0.6) 221 (1.5)	4.07 3.94	2.11 2.13
6	Vaccination ^{ab} Monensin (9ppm)	15,000 15,000	468 (3.1) 600 (4.0)	4.30 4.58	2.11 2.08

a. The levels of E. acervulina, E. maxima, E. necatrix and E. tenella in the 1.5% carrageenan solution were about 1,000, 100, 170 and 170 oocysts per bird respectively at 4 days of age. The birds were exposed again at 7 days of age to E. necatrix and E. tenella at about 130 oocysts per bird.

b. The mixtures were chilled in the refrigerator (4°C) overnight before use.

Therefore, it is preferred that the vaccine always be used in liquid form as opposed to gel form. All of the birds were kept for 51 days. The mean average weight gain in all of the tests was 4.25 plus or minus 0.02 for the vaccinated birds and 4.27 plus or minus 0.04 for the Monensin medicated birds. The average feed conversion for the vaccinated birds was 2.11 and for the Monensin medicated birds 2.10.

Unlike the battery tests discussed in Examples 1 to 3 of this application, where the birds were raised on wires, tests 1 to 6 of Table 5 were carried out with the birds raised on the floor. Therefore, self-infection or repeated exposure was extremely likely in the latter tests. Because of this probability, lower levels of oocysts were used. For example, in the case of Eimeria tenella, the total number of oocysts used was 300 in the two feedings rather than a multiple of 300.

The level of infectivity of oocysts used in the solution will vary greatly with the type of coccidium or coccidia in the solution. For example, with Eimeria tenella, a level of 5,000 is high because a level of 20,000 is lethal. On the other hand, with Eimeria acervulina, a level of 10,000 is low because a level of 1,000,000 is not lethal. The level of infectivity of the oocysts will also vary with the age and weight of the animals to be treated as well as the exposure time and whether the poultry are raised on the floor or on wire. With Eimeria tenella, a level of infectivity of 100 oocysts per millilitre of solution is preferred for four day old chicks. Other levels can readily be determined by those skilled in the art by reference to the level of a lethal dosage for a particular species of coccidium and by reference to the examples herein.

Since the vaccine can be given readily to the animals to be immunized on more than one occasion, it is not necessary by this method to control the moisture level of the litter or to be concerned with the litter at all. Also, since one or more species of coccidia can be used in the same solution, great flexibility can be achieved while minimizing the chance that extraneous species will be introduced into the vaccine.

In field trials using the method and vaccine of the present invention flocks of poultry, exceeding 20,000 birds, were treated simultaneously with little or no mortality, while achieving weight gain and feed conversion at least equal to that of flocks medicated with Monensin.

Claims

- 25 1. A vaccine, which can be taken orally, for immunizing domestic animals of the avian species from coccidiosis characterized by the vaccine comprising oocysts of at least one coccidium in relation to which immunization is desired, said oocysts of said coccidium being diluted in a solution which results in uniform suspension and infection in said oocysts.
- 30 2. A vaccine as claimed in Claim 1 characterized in that the solution contains a non-sticky, edible gum.
- 35 3. A vaccine as claimed in Claim 2 characterized in that the edible gum solution is approximately a 1.5% solution.
- 40 4. A vaccine as claimed in any one of Claims 1, 2 or 3 characterized in that the coccidium is Eimeria tenella.
- 45 5. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is carrageenan.
- 50 6. A vaccine as claimed in any one of Claims 1, 2 or 3 characterized in that the number of species of coccidia ranges from two to six selected from the group consisting of Eimeria necatrix, Eimeria tenella, Eimeria hagani, Eimeria acervulina, Eimeria maxima, Eimeria brunetti, Eimeria proecox, Eimeria mivati and Eimeria mitis.
- 55 7. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is suspended in water.
- 60 8. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is suspended in water and the coccidium is Eimeria tenella.
- 65 9. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is carrageenan and it is suspended in water.
- 70 10. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is carrageenan, the coccidium is Eimeria tenella and the carrageenan is suspended in water.
- 75 11. A vaccine as claimed in any one of Claims 2 or 3 characterized in that the edible gum is carrageenan and the number of species of coccidia ranges from two to six selected from the group consisting of Eimeria necatrix, Eimeria tenella, Eimeria hagani, Eimeria acervulina, Eimeria maxima, Eimeria brunetti, Eimeria proecox, Eimeria mivati and Eimeria mitis.



DOCUMENTS CONSIDERED TO BE RELEVANT									
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)						
X	EP-A-0 134 703 (UNILEVER N.V.) * Page 1, lines 3-9; claims 1,2,6,7,9,14,28; page 6, lines 8,9,18-20 *	1-11	A 61 K 39/012 A 61 K 47/00						
X	--- FR-A-2 408 351 (UNILEVER N.V.) * Claims 1,8,9,12 *	1,2,7							
A,D	--- US-A-3 147 186 (S.A. EDGAR) * Claims 1-6 *	1,4							
A	--- GB-A-2 059 769 (NISSHIN FLOUR MILLING CO.) -----								
TECHNICAL FIELDS SEARCHED (Int. Cl.4)									
A 61 K									
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%; padding: 2px;">Place of search</td> <td style="width: 33%; padding: 2px;">Date of completion of the search</td> <td style="width: 33%; padding: 2px;">Examiner</td> </tr> <tr> <td style="padding: 2px;">THE HAGUE</td> <td style="padding: 2px;">13-11-1986</td> <td style="padding: 2px;">CUENDET P.A.</td> </tr> </table>				Place of search	Date of completion of the search	Examiner	THE HAGUE	13-11-1986	CUENDET P.A.
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CATEGORY OF CITED DOCUMENTS		<p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>							
<p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technical background O : non-written disclosure P : intermediate document</p>									